Statement of Opinions
Wayne M. Grip
President
Aero-Data Corporation

Illinois River Watershed

Case No.: 4:05-cv-00329-GKF-SAJ
United States District Court
Northern District of Oklahoma

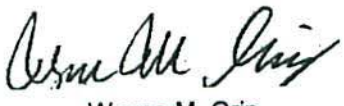
In the Matter of

State of Oklahoma, ex rel. W.A. Drew Edmondson, in his capacity as Attorney General of the State of Oklahoma and Oklahoma Secretary of the Environment C. Miles Tolbert, in his capacity as the Trustee for Natural Resources for the State of Oklahoma

v.

Tyson Foods, Inc., Tyson Poultry, Inc., Tyson Chicken, Inc., Cobb-Vantress, Inc., Aviagen, Inc., Cal-Maine Foods Inc., Cal-Maine Farms Inc., Cargill Inc., Cargill Turkey Production, LLC, George's Inc., George's Farms, Inc., Peterson Farms Inc., Simmons Foods, Inc., and Willow Brook Foods, Inc.

October 2008



Wayne M. Grip

Assignment

I was engaged to provide a historical aerial photography study of the Illinois River drainage basin (Site) which involved several different photointerpretation and mapping assignments. First, I was asked to map the main channel of the Illinois River from its headwaters to Lake Tenkiller over multiple dates so as to identify the areas where the Illinois River channel had changed in position over time (meandered). It is well understood in the field of geology that the meandering of a stream channel is associated with stream bank erosion and transport of sediment down stream.

In conjunction with the first assignment, I also completed a more detailed, multi-date historical aerial photography study of a small section of the Illinois River where one of the larger active meander areas is visible. This detailed study will allow me to demonstrate in trial, using additional dates of georegistered stereoscopic aerial photography, how a section of the Illinois River channel meandered from 1958 to 2008.

Finally, I was asked to quantify the acreage of newly developed residential and commercial parcels of land that appeared within the eastern portion of the Illinois River basin from the late 1970's to the present time. I am aware that new development within this area has been rapid in the last thirty years. The eastern side of the fairly large study area that I chose includes portions of the towns of Rogers, Springdale and Fayetteville, Arkansas and extends a distance of 25.4 miles from north to south and 7.3 miles from east to west. I planned to interpret and map the newly developed areas for each of four periods of time. It is my understanding that the amount of new development within the Illinois River basin is relevant in this litigation, because new development involving the conversion of agricultural lands to residential or commercial typically results in increased precipitation runoff, soil erosion and sediment transport into adjoining streams and thus potentially into Lake Tenkiller.

Report organization and methods

The exhibit section of my report contains georegistered images derived from aerial photography and maps that should be reviewed while reading this expert report. These images are the main source of information contained in my report and will be used during my testimony. In addition, the exhibit section contains the aerial photography, maps and vector overlays I digitized which show the shifting positions of the Illinois River channel for the 1970's to the present (Figures 2-33). Other vector overlays show the outlines of recently developed areas located within the eastern portion of the Illinois River drainage basin between the towns of Rogers and Fayetteville, Arkansas. The exhibit section also contains other overlays, not created by me and available in the public domain, such as the outline of the Illinois River drainage basin and the dense network of drainage channels that drain into the Illinois River.

Aerial photography and maps were acquired of the Illinois River basin from both public and private sources. In addition, I obtained multiple edition dates in a digital raster format of the USGS 7.5 minute 1:24,000 scale Quadrangle Sheets (DRG's) and the Digital Ortho Quarter Quads (DOQQs) that provided coverage of the Site. These maps and photographs were already registered in the UTM coordinate system. The unregistered aerial photographs that I also

obtained were scanned, and the images were registered to the same coordinate system as the DRG's using digital photogrammetric procedures (soft copy). As a result, all of the aerial photography and maps used in my study were registered in the same coordinate system (UTM Z15N Nad83) in a geographic information system (GIS). This allowed viewing of the images, interpretation, mapping and distance measurements on a computer in a time lapse format.

Illinois River channel findings

Using the GIS, I mapped both banks of the main channel of the Illinois River for each three different dates (early 70's, 1994/95 and 2006). Each date was mapped in a different color: green (70's), red (1994/95) or blue (2006). This showed the changes to the channel over a 34 year long interval. For each date interpreted and mapped, this produced a long narrow polygon winding through the drainage basin from the headwaters of the river to Lake Tenkiller. I found that the active meanders of the digitized main channel over the 34 year period of time were clearly visible even when zoomed out far enough in the GIS to see a twenty mile long section of the river on the computer screen.

The main channel moved laterally within many of the meander areas a distance of over 500 feet and in one case over 1,000 feet. The average width of the river channel as I mapped it was approximately 100 feet. Some of the meander areas are thus five to ten times as wide as the average river channel. Other sections of the river were relatively straight without present day active meanders. Between the early 1970's and 2006, the straight sections of channel typically moved less than one half of a channel width.

In some areas, the outer bends of the meanders were cutting into flat, level banks which were over ten feet higher than the channel water elevation. In other areas, the channel meander was reworking relatively recent point bar deposits which were just a few feet higher than the channel water elevation. The meandering is more significant in the lower reaches of the main channel of the Illinois River which is located within Oklahoma than it is in the upper reaches located within Arkansas.

Finally, I chose a short section of the lower reach of the Illinois River located near the Echota public use area and produced multiple georegistered, primarily stereoscopic dates of aerial photography so as to allow for more a detailed visualization of one of the meander areas. This detailed study showed the gradual shifting position of the main channel on twelve separate dates (Figures 34-46).

New residential and commercial development findings

The final task I was given was to measure the amount of development that had taken place within the Rogers to Fayetteville, Arkansas area. I chose to map the new land development of a fairly large region occurring within the area covered by the Bentonville South, Springdale and Fayetteville 7.5 minute USGS Quadrangle Sheets which were also within the Illinois River drainage basin (Figures 47-49). This study area covers approximately 97,334 acres or 152 square miles. The dimensions of the study area are 25.4 miles north/south by 7.3 miles

east/west. Based on my research of aerial photography and maps, I determined that adequate coverage was available for four separate periods as follows: 1976/1982, 1994/1995, 2001 and 2006. The photography and maps did not cover a single year for the earliest two periods. A 1976 edition date quadrangle sheet was used for Bentonville South and 1982 edition date quadrangle sheets were used for Springdale and Fayetteville. The 1982 edition date Bentonville South quadrangle sheet was never produced by the USGS.

The initial period that I mapped to show existing development at the start of the study thus covered the period of time from 1976 or 1982. The existing developed areas were interpreted and mapped from existing USGS quadrangle sheets which depicted the existing roads and nearly all of the buildings. I digitized developed area polygons around the building symbols on the quadrangle sheets in an appropriate size based in part on the same structures visible in the 1994/1995 photography. By definition, the developed areas I mapped were for residential or commercial use. They were not used for crops, pasture, parkland, golf courses, or forestry. By 1982, portions of the three towns were already densely but not completely developed with multiple large polygons of developed land while the rural areas had many small developed area polygons resulting from small farm homesteads. Many of the farm homesteads have changed little up to the present except for those which have been lost to new residential developments. The developed area polygons are depicted in a solid gray in color for this initial period. A total of 12,309 acres of developed land representing 12.6 % of the study area was mapped for the initial period.

The next date mapped was 1994/1995. This was accomplished using georegistered monoscopic aerial photography. Large, new residential and commercial developments constituted most of the increases in developed area. A total of 9,491 acres of newly developed land representing 9.8% of the study area was mapped for this second date. The polygons are depicted in a solid red color for this period and represent the development between 1976/82-1994/95. The cumulative development of the study area by this date has nearly doubled at 22.4%

The next date interpreted and mapped was 2001. This was also accomplished using georegistered monoscopic aerial photography. Large, new residential and commercial developments again constituted most of the increases in developed land. A total of 6,818 acres of newly developed land representing 7% of the study area was mapped in 2001. The polygons are depicted in a solid blue color for this period and represent the development between 1994/95-2001. The cumulative development of the area has nearly tripled to 29.4 %

The final date mapped was 2006. This was also accomplished using georegistered monoscopic aerial photography. New residential and commercial developments again constituted most of the increases in developed land. A total of 9,594 acres of newly developed land representing 9.9% of the study area was mapped for 2006. The polygons are depicted in a solid green color for this period and represent the development between 2001-2006. The cumulative development of the area has increased to 39.3%.

Statement of Qualifications

My name is Wayne M. Grip. I have a BS degree in Geology from the University of Wisconsin, Madison. After I received my degree in Geology, I served as a cartographic officer in the US Air Force for four years. In this position, I interpreted aerial photography and satellite imagery to produce air target charts (maps). Following my release from active duty, I returned to the University of Wisconsin, Madison and took additional courses in soils and groundwater conservation. Following my completion of this training, I accepted positions as a golf course superintendent in Milwaukee, Wisconsin and then in Dallas, Texas. Next, I worked for the Louisiana Department of Natural Resources as a geologist. In this position, I interpreted aerial photography to evaluate mining permit applications and to monitor oil and gas and mining operations. I also conducted many on-site inspections to determine the compliance of regulated facilities with environmental standards. Assuring the reclamation of mined lands was one of my key responsibilities in this position.

In 1982, I co-founded Aero-Data Corporation. I am currently the president and principal owner. Aero-Data specializes in aerial mapping and environmental studies using aerial photography and historic maps. I have over twenty-nine years of professional experience in this field and have served as an expert witness in the areas of photointerpretation, photogrammetry, and hydrology in both federal and state courts in the United States. I am also an active licensed pilot with over 2,800 hours of flying time as pilot in command including over 1,000 hours of photomissions. In the past twenty-five years with Aero-Data Corporation, I have completed over 700 environmental site investigations in more than thirty states using historical aerial photography.

My client list includes many major corporations as well as government agencies such as the US Department of Justice, the Louisiana Department of Natural Resources, and the Louisiana Department of Environmental Quality.

Information Considered in Producing my Report

My work is based upon vertical stereoscopic and monoscopic aerial photography, imagery, maps and digital geographic data of the site as well as my experience and training.

Area of Expertise in Which I Expect To Testify

I expect to testify in the areas of photogrammetry and photointerpretation. Photogrammetry is defined as the science of taking measurements from photography. In practical terms, photogrammetry is the science of making maps. Photointerpretation is the science of identifying objects in photography and determining their meaning. Attachment C is my current resume, and Attachment D is a listing of my trial and deposition testimony. My billing rate is $200 per hour.

All data used in this report is listed in Attachment A. The exhibit section of my report (Figures 1-49) has been printed and is included in Attachment B.

Methods and Materials

* Aerial Photography research and acquisition

The historical aerial photography study of the Site began with research for available photo coverage from both public and private vendors. The photo coverage was then purchased in the form of frames of film consisting of vertical stereoscopic photography in a 9"x9" format. Photographic coverage was also purchased from the government in a monoscopic georegistered format called digital ortho quarter quads (DOQQ's). Maps were also purchased from the government in the form of scanned and georegistered United States 1:24,000 scale quadrangle sheets (raster quads).

* Initial photography review and date verification

As the film for each photo mission (date of photography) was received from the aerial film vendors, the shipment was examined for proper geographic coverage of the Site and filed into separate folders for each photo mission. If the geographic coverage provided by the film was incomplete (or covering the wrong area), my research staff contacted the provider to resolve the error (or reconfirm the lack of availability of full coverage of the Site).

Next, I reviewed the film in stereo using a tracking mirror stereoscope mounted on a light table. I verified the date of the photo mission and confirmed that the film was of sufficient resolution and provided the necessary geographic coverage of the Site.

Not all of the images were obtained in a film format. Some of the photomissions were obtained from the USDA/NAIP and the USGS in orthophoto format. Stereoscopic images were not available for these orthophoto products. For those photomissions in which orthophotos were provided, no additional work by Aero-Data other than importing the images into a geographic information system was required as the scanning and registering steps had already been completed by the provider.

* High resolution scanning of selected photography

In accordance with typical photogrammetry industry procedures, the selected film was scanned one 9"x9" frame at a time at a resolution of 12.5 microns (2032 dots per inch) using a Leica DSW700 photogrammetric scanner designed to produce very high resolution, virtually distortion-free raster images. At this scanning resolution, each raster image produced from a single frame of film is composed of over three hundred million pixels (picture elements). The file size of each black and white image scanned at 12.5 microns is approximately three hundred megabytes. A color image is three times larger (approximately 1 gigabyte). The scanned images are true reproductions of the original photography. They are not enhancements. The United States Geological Survey (USGS) now only provides scanned copies of its photography usually at 10 to 25-micron resolution using scanners similar to the one used by me. The USGS no longer provides film copies. This change was implemented in September 2004.

* Setting up the stereo models

Two or more high-resolution raster images for each stereo date of photography were then imported into a digital stereo plotter capable of providing stereoscopic viewing of the images at magnification levels ranging from 1X to 128X. The digital stereo plotter also allows precise mapping of significant environmental features, which are interpreted, in the 3-D imagery.

Ground control for the initial date 4/24/1991 was derived from the USGS Digital Ortho Quarter Quads (DOQQs) and quadrangle sheets (1:24,000 scale) of the area. Distant mapped features, thousands of feet off the Site but which were also visible in the aerial photography, were measured (coordinates derived) from the USGS DOQQs and used as ground control points.

The coordinates of each selected visible ground control point were then entered into a control point file in the digital stereo plotter. The floating dot (measuring point) of the stereo plotter was carefully positioned by the operator with the hand controller, one point at a time, onto each of the visible control points, and the coordinates of that point (from the ground control point file) were assigned to the image. When sufficient control points had been visited, accepted and the model checked for residual errors, the stereo model was then confirmed to be level, scaled and locked into the coordinate system.

Other stereo models for additional photomissions were then set up using ground control points derived from the initial stereo model. This assured that the stereo models for all dates were very accurately registered one to another in the same coordinate system.

* Digital orthophoto production

Next, using the stereo models and digital stereo plotter, a digital orthophoto was produced for each date of photography. A digital orthophoto is a two dimensional raster image produced from one or more frames of vertical aerial photography such that most of the distortion (caused by terrain displacement and tip and tilt in the mapping camera) has been removed. The resulting raster image is accurately registered to a chosen coordinate system. As a result, each digital orthophoto accurately depicts the roads, buildings, tanks and other significant features located

within the Site in their true geographic position. However, distortion caused by the height of buildings was not removed. As a result, the bases of these structures are displayed in their true position, while their tops may be displaced.

Digital orthophotos are widely accepted today by both government and industry as an improvement over the base maps and photomosaics previously used to show the locations of features within a geographic area. Digital orthophotos have the accuracy of a stereo plotter or land survey produced map with the resolution of a photograph. Digital orthophoto mosaics are far more accurate and easier to produce than photomosaics.

* ArcView GIS

The digital orthophotos with the interpretation overlays were next imported into ArcView GIS. ArcView is a very popular geographic information system (GIS) produced by ESRI and sold throughout the world. For the purposes of this report, the images will be referred to as "registered images". Hard copies of the registered images were then printed in an 8.5"x11" format from a PC using a high-resolution printer. They are included in this report (Attachment B).

The images were prepared so that they may also be viewed using a computer projection system running ArcView or PowerPoint software. ArcView GIS provides a wide range of capabilities such as zooming, turning themes (layers) on and off and measuring distances. Other geographic information systems can provide the same capabilities. The images and maps will likely be used as exhibits by other experts at trial.

AERO-DATA CORPORATION

Attachment A - Illinois River Information Relied Upon

DOCUMENT/ PHOTO DATE	DOCUMENT/ PHOTO SOURCE	PHOTO RATIO	FILM TYPE	ROLL NUMBER	FRAMES FOR PROJECT	DESCRIPTION	RESEARCH STATUS
6/27/1958	USDA	20000	BW	7V	49-50		Mapped
11/12/1964	USDA	20000	BW	2FF	212-213		Mapped
1/1/1972	MAPEXPRESS	24000	MAP		Tahlequah		Mapped
4/4/1972	USDA	40000	BW	272	124-125		Mapped
11/28/1979	USDA	40000	BW	179	101-102		Mapped
7/22/1984	USDA	58000	CIR	3084	88-89		Mapped
4/24/1991	USDA	40000	BW	5190	18-19		Mapped
1/1/1992	USGS	250000	MAP		txu-pclmaps-topo-us-russelville-1992		Mapped
3/3/1994	USGS-DOQQ	40000	BW		see comments		Mapped
3/15/1994	USGS-DOQQ	40000	BW		see comments		Mapped
2/18/1995	USGS-DOQQ	40000	BW		see comments		Mapped
2/25/1995	USGS-DOQQ	40000	BW		see comments		Mapped
3/9/1995	USGS-DOQQ	40000	BW		see comments		Mapped
3/21/1995	USGS	40,000	BWN	8436	48-49		Mapped
3/21/1995	USGS-DOQQ	40000	BW		see comments		Mapped
3/23/1995	USGS-DOQQ	40000	BW		see comments		Mapped
3/26/1996	USGS-DOQQ	40000	BW		see comments		Mapped
2/5/2001	USGS-DOQQ	40000	CIR		see comments		Mapped
2/19/2001	USGS-DOQQ	40000	CIR		see comments		Mapped
1/1/2003	USDA_NAIP	40000	COL		.sid		Mapped
1/1/2004	USDA_NAIP	40000	COL		.sid		Mapped
1/1/2005	USDA_NAIP	40000	COL		.sid		Mapped
1/1/2006	USDA_NAIP	40000	COL		.sid		Mapped
1/1/2008	USDA_NAIP	40000	COL		.sid		Mapped

Attachment B